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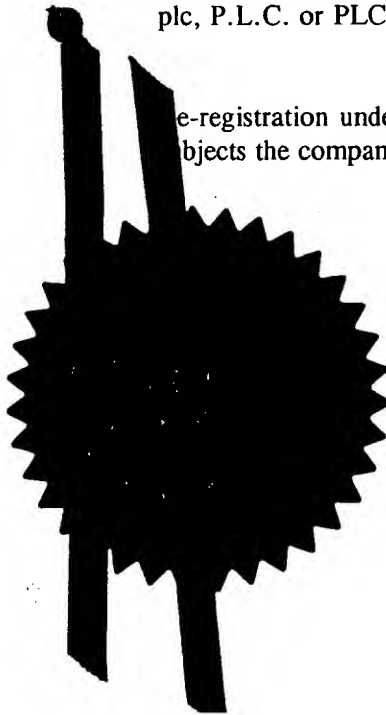
16 FEB 1999
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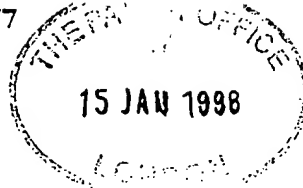
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Andrew Gersey

2nd February 1999

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1. Your reference

P14373

2. Patent application number

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9800861.8

15 JAN 1998

3. Full name, address and postcode of the or of each applicant (underline all surnames)

NOPPADOL AMORNTATKUL
17/21 SUKHUMVIT 101/1 BANGCHAK
PRAKANONG BANGKOK 10260
THAILAND

Patents ADP number (if you know it)

7360373001

If the applicant is a corporate body, give the country/state of its incorporation

THAILAND

4. Title of the invention

FORGING OF WORKPIECES

5. Name of your agent (if you have one)

"Address for service" in the United Kingdom
to which all correspondence should be sent
(including the postcode)

EDWARD EVANS & CO
CHANCERY HOUSE

Patents ADP number (if you know it)

661001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number
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Date of filing
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7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing
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8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

- a) any applicant named in part 3 is not an inventor, or
 - b) there is an inventor who is not named as an applicant, or
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YES

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Continuation sheets of this form

Description 9

Claim(s) 4

Abstract 1/4

Drawing(s) 6

10. If you are also filing any of the following, state how many against each item.

Priority documents

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Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77)

Request for substantive examination (Patents Form 10/77)

Any other documents (please specify)

11.

I/We request the grant of a patent on the basis of this application.

Signature

Edward E

Date 15.1.1997

12. Name and daytime telephone number of person to contact in the United Kingdom

TERRY L. JOHNSON - 0171 405 4916

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According to a first aspect of the invention there is provided apparatus for cold forging a metal workpiece, comprising a die with means to alleviate stress to the workpiece during forging.

According to a second aspect of the invention there is provided apparatus for enlarging part of a metal workpiece by cold forging, compressing an enlarging die with means to alleviate stress to the workpiece during forging.

Using the invention it is possible to provide an enlarged end of deformed (ribbed) and undeformed reinforcement bars without changing their overall tensile characteristics.

The stress alleviating means may comprise a relief channel into which metal can flow during forging. This is a relatively simple yet effective construction, particularly where the relief channel may be a substantially U-shaped groove in the die.

There may be two opposed dies. This provides for positive enlargement over the whole circumference of the workpiece.

Each die may have a first die part and a second die part which second die part may be enlarged relative to the first die part and may be adapted to allow part of the workpiece to project therefrom, the arrangement being such that in use the projecting part of the workpiece is upset and enlarged. This is a particularly simple and efficient construction.

There may be means to press the die parts together, and means to apply pressure in a direction substantially at 90° to the first-mentioned press

FORGING OF WORKPIECES

The invention relates to forging of workpieces, particularly metal workpieces such as reinforcing bars for use in building construction, particularly concrete construction.

Concrete reinforcing bars, which may be deformed by external ribs, or plain, are usually provided in finite lengths.

It is often necessary to join them in line to provide a more extensive reinforcement than might otherwise be possible owing to the finite length. Such bars have a high tensile strength, and it is accordingly necessary not to undermine that strength during any process to enable the bar to be connected with another. Usually this is effected by providing a thread on one end, usually by cold working, which can be advantageous as the bars are usually made from steel with a high carbon and manganese content. However, forming a thread at one end of the bar often reduces the cross-section of the bar, thus lowering its tensile cross-section in the region of the thread, which leads to failure in use, which can be catastrophic for the concrete. It is thus necessary to ensure that the threaded end (which is formed by rolling, milling or cutting) is enlarged, relative to the remaining length of the bar, so that the effective tension cross-section of the threaded part is not smaller than that of the remaining length of bar. However, in the past, enlarging techniques have not been able satisfactorily to produce an enlarged end of a ribbed bar in which the tensile strength is not effected as compared with that of the remainder of the bar.

It is an object of the invention to seek to mitigate these disadvantages.

cold forging an elongate metal workpiece, comprising the steps of providing forging apparatus having a die, providing the die with means to alleviate stress in the workpiece during forging, and forging the workpiece.

The method may include the steps of providing two opposed forging dies. This provides a positive method of operation.

Each forging die may comprise a relief channel into which material of the workpiece can flow during forging. This provides that the tensile integrity of the workpiece is maintained.

There may be the steps of providing that each die part has a first die part and a second die part enlarged with respect to the first die part, inserting an elongate workpiece between the dies so that the first die part receives a main part of the workpiece, and an end of the workpiece projects through and beyond the second die part, and upsetting the projecting end so that it flows into the enlarged second die part. This provides an efficient method of enlargement.

There may be the steps of removing the forged workpiece from the apparatus and forming a thread on the enlarged part of the workpiece. This provides a way to connect the workpiece with another similar one.

According to a fourth aspect of the invention there is provided an elongate metal workpiece whenever forged by a method as hereinbefore defined, or whenever produced by a method as hereinbefore defined.

The elongate metal workpiece may have at least one threaded end, and may

direction. This provides for maintaining a tensile integrity of the workpiece during a forging/enlarging procedure.

The means for pressing the die parts together may comprise an hydraulic press acting substantially vertically in use. This is an effective construction.

The second-mentioned means may comprise an hydraulic press acting substantially horizontally. This is also an effective construction.

At least the distance between the enlarging die and the substantially-horizontally acting hydraulic press may be adjustable. This provides for a desired enlarging operation.

The distance may be adjustable by adjusting the pressure of a forging piston for effecting forging. This is an effective way of adjusting the operation.

An equally effective alternative may be by the distance being adjustable by adjustment of a forging pad on which the forging piston can act.

The pressure of the substantially vertically acting hydraulic press may also be adjustable. This again provides a desired control of the procedure.

The first die part may have an internal die configuration substantially complementary to the external configuration of a major part of a workpiece which is to be forged. This provides for support of the workpiece during enlargement.

According to a third aspect of the invention there is provided a method of

Figs. 6 and 7 show an end elevational view of forging dies used in the apparatus of Figs. 4 and 5, Fig. 6 showing a reinforcing bar in position;

Fig. 8 shows a side elevational view of the forging dies of Fig. 6 with the reinforcing bar in position for enlargement of one end;

Figs. 9 to 11 show stages in the production of an enlarged threaded end of a reinforcing bar according to the invention;

Fig. 12 shows use of a reinforcing bar according to the invention; and

Fig. 13 shows a reinforcement system comprising a plurality of reinforcing bars according to the invention.

Referring to the drawings, there is shown apparatus 1 (Figs. 4 to 8) for cold forging or enlarging a metal workpiece in the form of a reinforcing bar 2 for concrete comprising a die 3 to alleviate stress to the workpiece 2 during forging.

Thus a reinforcing bar 2 with a very high tensile strength which has a variable outer configuration owing to the variation in the size and shape of surface deformations (ribs), particularly longitudinally extending ones 4 can be soft cold enlarged without reducing the mechanical characteristics and strength of the reinforcing bar 2. Thus the tensile strength and yield strength of the reinforcing bars are not reduced, unlike in the prior art of Figs. 1 to 3. Fig. 1 shows an end of a prior art reinforcing bar A which has been enlarged and then had a thread 'T' applied to it. There is a tendency for a crack 'C' to form, Figs. 2, 3, if the enlarging process is not controlled so that

comprise a reinforcing bar for use in building construction.

Such a reinforcing bar may have an internally threaded sleeve on an end opposite an enlarged threaded end.

According to a fifth aspect of the invention there is provided a reinforcing system, comprising a plurality of reinforcing bars as hereinbefore defined.

According to a sixth aspect of the invention there is provided concrete whenever reinforced by a workpiece or reinforcing bar as hereinbefore defined.

Apparatus and a method for cold forging or enlarging a metal workpiece by cold forging is hereinafter described, by way of example, with reference to the accompanying drawings.

Fig. 1 shows a copy of a photograph of the threaded end of a prior art deformed metal reinforcing bar for use in reinforcing concrete in building construction;

Fig. 2 shows a cross-section at 'b' in Fig. 1;

Fig. 3 shows an enlargement of C in Fig. 2, at a magnification of 20:1;

Figs. 4 and 5 show respectively schematic elevational views of apparatus according to the invention for soft-cold forging/enlarging of a metal reinforcing bar;

the enlargement is either too large or conversely too small. In this latter case, the failure occurs at the threaded section as the cross-sectional area of the thread is too small. Such dimensional irregularities will lead to early failure in use of the prior art bar A.

This is obviated using the apparatus 1 of Figs. 4 to 8, in which there is the die 3 in the form of a pair of substantially vertically (as viewed) opposed dies 5, 6, each having a relief or stress alleviating means in the form of a relief channel or track 7 or substantially U-shaped groove which extends from a second die part 8 or enlarging die which is enlarged with respect to a first die part 9. There is also a tapered transition or contour 10 between the first and second die parts 9, 8 which allows a controlled application of pressure.

The first die part 9 is complementary to the outer diameter of the main body part of the reinforcing bar 2. The length of the dies 5, 6 is such that the reinforcing bar 2 at one end extends through and beyond the enlarged die part 8. The apparatus 1 includes a first pressure applying means in the form of an hydraulic press 11 which acts substantially vertically (as viewed) to act on the main part of the reinforcing bar by pressing on the ribs 4. This reduces the risk of increasing stress in the reinforcing bar 2 during enlargement of the end. There is also a second pressure applying means in the form of an hydraulic press 12 which acts substantially horizontally (as viewed). The horizontal distance can be adjusted as desired by adjusting the distance of the piston 13 and/or by adjusting a pad or disc 14 which pad or disc 14 is intermediate the piston 13 and the enlarged die part 8. The effect is to adjust the distance of the reinforcing bar which projects beyond the enlarged die part 8. Other means of adjustment may be utilised.

In operation to form an enlarged end 2a of the reinforcing bar 2, the dies 5, 6 are separated vertically, the reinforcing bar 2 is inserted through a guide and support 15 in a frame 16 of the apparatus 1, so that the end to be enlarged projects beyond the enlarged die parts 8. The bar 2 is then pressed by lowering the die part 5 vertically, arrow 'X' via its piston 17 to engage the lower die part so that the bar 2 is supported over substantially the whole length of its main body. Then the hydraulic press 12 is actuated to act on the projecting end to upset it in a cold forging operation, the relief grooves or tracks 7 allowing the upsetting to take place without the imposition of additional stresses during enlargement. Also, the grooves 7 allow the shape and dimensions to be controlled in a positive manner, which control is assisted by the tapered zone 10, which with the relief grooves 7 allows a smooth, controlled enlargement with alleviation of stress build up, so that the bar has a tapered part 17 between the main body and the enlarged end 2a with no additional stresses.

After enlargement of one end, the other end can be enlarged too, or not. The enlarged end(s) is/are then threaded by rolling, milling or broaching to form a thread 18. As the enlarging operation is effected cold, with no increase in stress, the material of the enlarged end is "soft", so facilitating a rapid thread-cutting operation without damage to the thread cutting tools. The provision of soft cold forging allows for stress relieving so that there is no increase in stress in the enlarged end, and the control of the distance of the projecting reinforcing bar beyond the enlarging dies 8 provides the desired proper size of the end being enlarged. Thus the enlarged end is not too large (which would create a crack in the enlarged end), and not too small (which would create failure in the thread region), according to the particular size and shape of the reinforcing bar being enlarged.

CLAIMS

1. Apparatus for cold forging a metal workpiece, comprising a die with means to alleviate stress to the workpiece during forging.
2. Apparatus for enlarging part of a metal workpiece by cold forging, comprising an enlarging die with means to alleviate stress to the workpiece during forging.
3. Apparatus according to Claim 1 or Claim 2, the stress alleviating means comprising a relief channel into which metal can flow during forging.
4. Apparatus according to Claim 3, the relief channel comprising a substantially U-shaped groove in the die.
5. Apparatus according to Claim 3 or Claim 4, there being two opposed dies.
6. Apparatus according to Claim 5, each die having a first die part and a second die part which second die part is enlarged relative to the first die part and is adapted to allow part of the workpiece to project therefrom, the arrangement being such that in use the projecting part of the workpiece is upset and enlarged.
7. Apparatus according to Claim 6, comprising means to press the die parts together, and means to apply pressure in a direction substantially at 90° to the first-mentioned press direction.

Fig. 12 shows a reinforcing bar 2 with an internally threaded sleeve 19 on one end in concrete 20 about to be connected with a reinforcing bar 2 according to the invention, the threaded enlarged end 2a, 18 being screwed into the sleeve 19 to effect connection. This can be effected manually on site, with the aid if required of pliers or tongs. Fig. 13 shows a reinforcement for concrete in the form of a complete system of reinforcing bars connected together - looking from the left there is a bar 2' with a sleeve 19 (like that of Fig. 12) a bar 2'' with enlarged threaded ends, a bar 2''' with a threaded sleeve 19 at each end, a bar 2'''' with a threaded enlargement at one end and an internally threaded sleeve 19 at the other, a bar 2⁵ with a double external enlarged thread at each end, a sleeve 21 with internal threads at both ends and a bar 2⁶ with an enlarged threaded end. These, it will be understood, are examples of possible combinations for connecting reinforcing bars embodying the invention in a reinforcement system for concrete.

It will be understood too that the apparatus 1 described with reference to the drawings provides a regular and homogenous enlarged end 2a in which the stresses are virtually identical to those in the unenlarged part of the bar so that a full load can be applied when used in concrete constructions. Moreover, cold enlarging as described herein with reference to the drawings is also advantageous in that it can be carried out at a desired location, e.g. a construction or job site, as the apparatus can be mobile. Also, cold enlarging is less expensive than hot enlarging as no heating energy is required, and no additional time need be allowed for heating up and cooling down of a workpiece.

means to alleviate stress in the workpiece during forging, and forging the workpiece.

17. A method according to Claim 16, the method including the steps of providing two opposed forging dies.

18. A method according to Claim 17, each forging die comprising a relief channel into which material of the workpiece can flow during forging.

19. A method according to Claim 18, including the steps of providing that each die part has a first die part and a second die part enlarged with respect to the first die part, inserting an elongate workpiece between the dies so that the first die part receives a main part of the workpiece, and an end of the workpiece projects through and beyond the second die part, and upsetting the projecting end so that it flows into the enlarged second die part.

20. A method according to Claim 19, including the steps of removing the forged workpiece from the apparatus and forming a thread on the enlarged part of the workpiece.

21. A method of cold forging an elongate workpiece, substantially as hereinbefore described with reference to the accompanying drawings.

22. An elongate metal workpiece whenever forged by apparatus according to any of Claims 1 to 15, or whenever produced by a method according to any of Claims 16 to 21.

23. An elongate metal workpiece according to Claim 22, having at least

8. Apparatus according to Claim 7, the means for pressing the die parts together comprising an hydraulic press acting substantially vertically in use.
9. Apparatus according to Claim 7 or Claim 8, the second-mentioned means comprising an hydraulic press acting substantially horizontally.
10. Apparatus according to Claim 9, at least the distance between the enlarging die and the substantially-horizontally acting hydraulic press being adjustable.
11. Apparatus according to Claim 10, the distance being adjustable by adjusting the pressure of a forging piston for effecting forging.
12. Apparatus according to Claim 11, the distance being adjustable by adjustment of a forging pad on which the forging piston can act.
13. Apparatus according to any of Claims 9 to 12, the pressure of the substantially vertically acting hydraulic press being adjustable.
14. Apparatus according to any of Claims 6 to 13, the first die part having an internal die configuration substantially complementary to the external configuration of a major part of a workpiece which is to be forged.
15. Apparatus for cold forging/enlarging a metal workpiece, substantially as hereinbefore described with reference to the accompanying drawings.
16. A method of cold forging an elongate metal workpiece, comprising the steps of providing forging apparatus having a die, providing the die with

one threaded end.

24. An elongate metal workpiece according to Claim 23, comprising a reinforcing bar for use in building construction.

25. A reinforcing bar according to Claim 24, having an internally threaded sleeve on an end opposite an enlarged threaded end.

26. A reinforcing system, comprising a plurality of reinforcing bars according to any of Claims 22 to 25.

27. A reinforcing bar, substantially as hereinbefore described with reference to the accompanying drawings.

28. Concrete whenever reinforced by a workpiece or reinforcing bar according to any of Claims 22 to 27.

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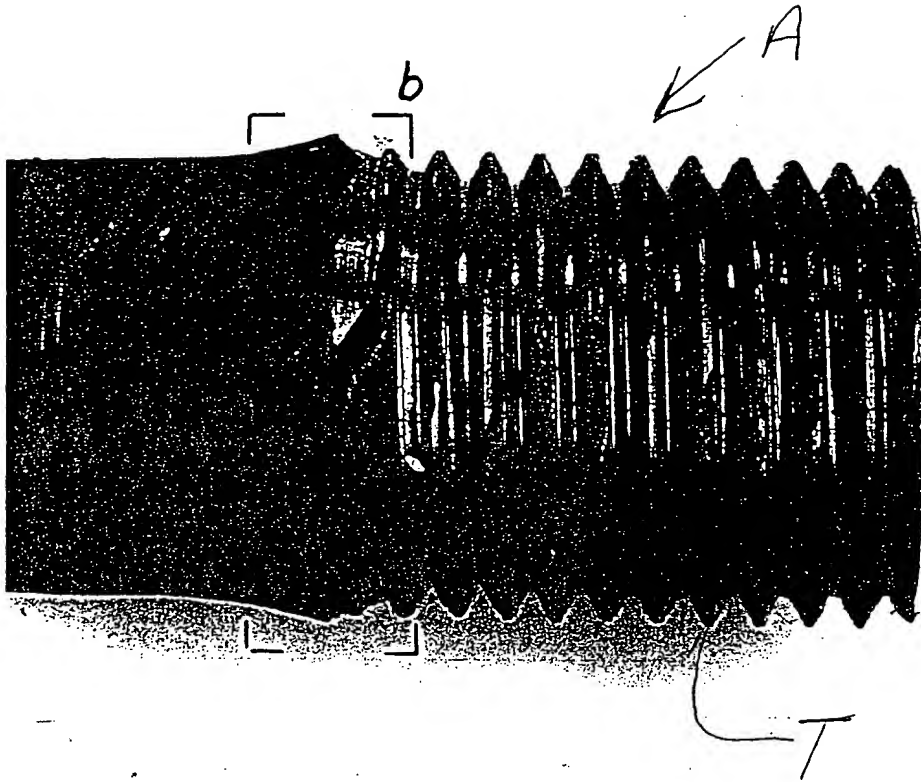
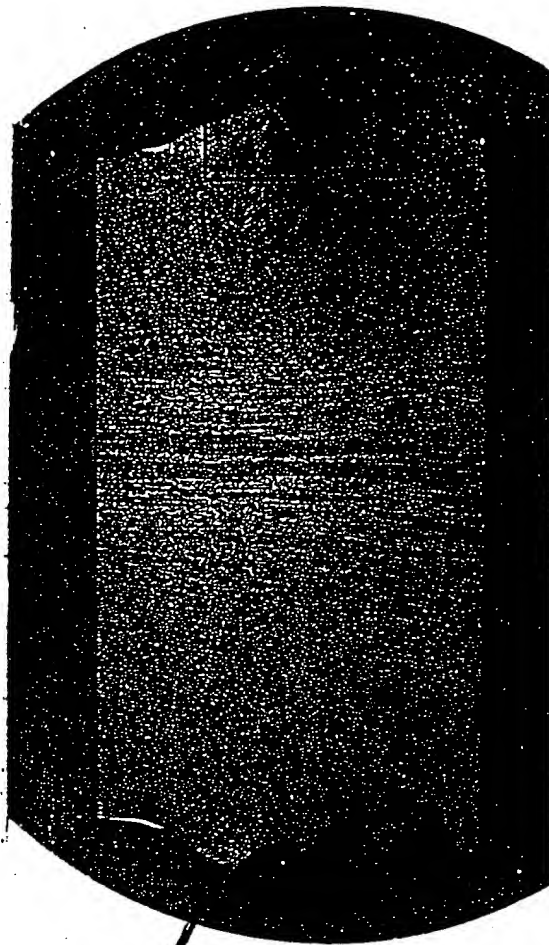


FIG 1

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A

T

FIG 2

3/6

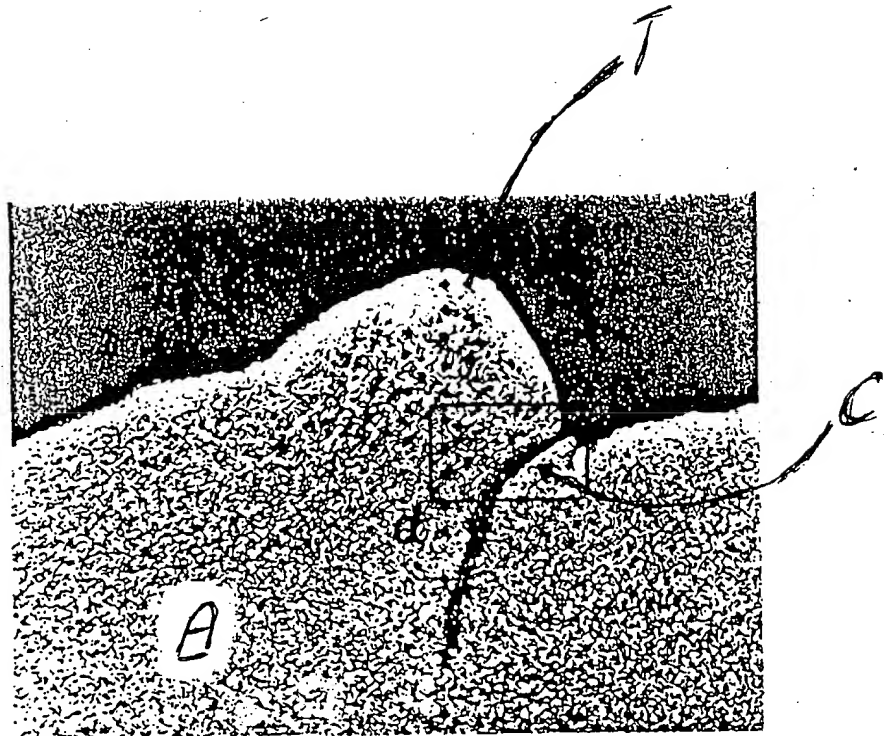


FIG 3

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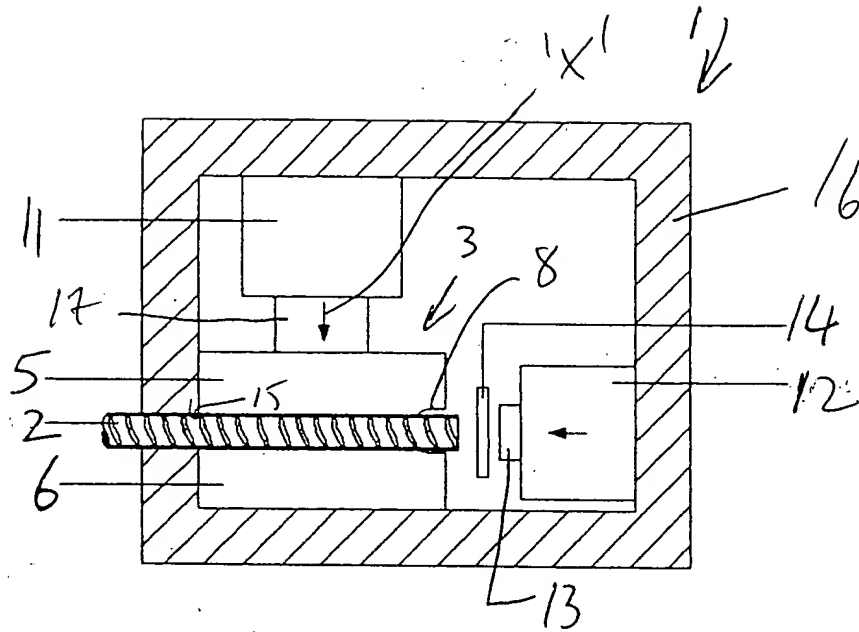


Fig. 4

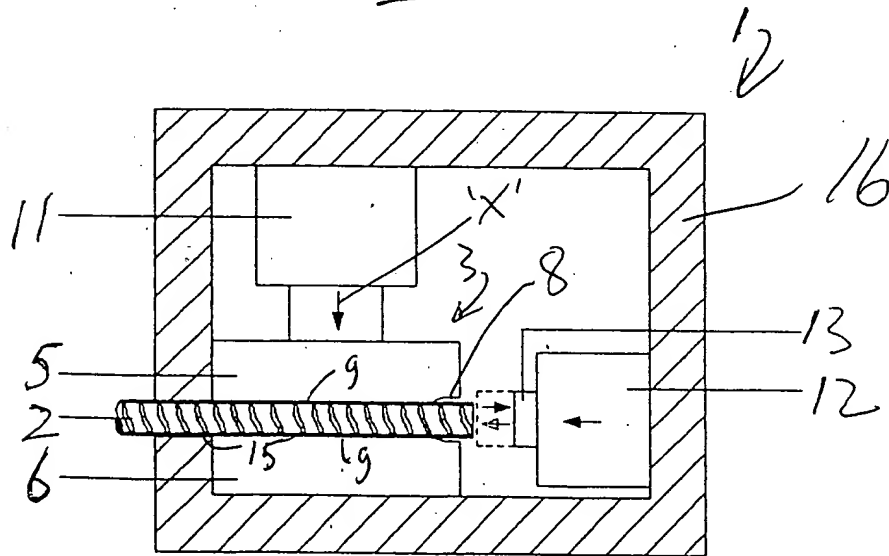


Fig. 5

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FIG 6

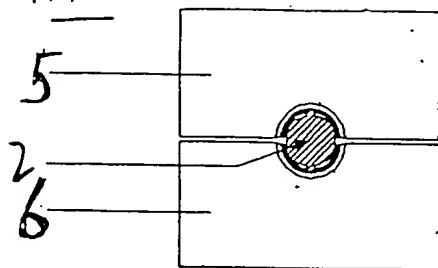


FIG 7

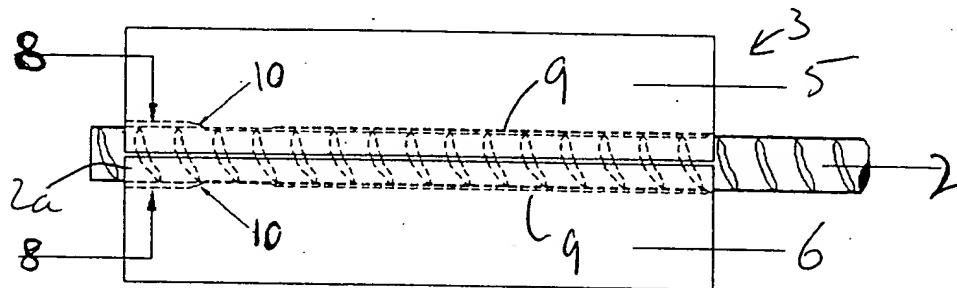
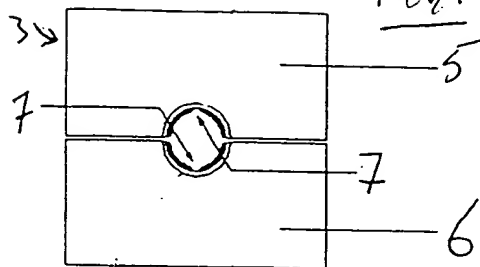


FIG 8

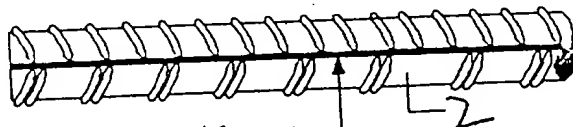


FIG 9

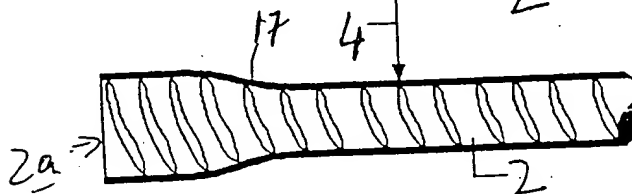


FIG 10

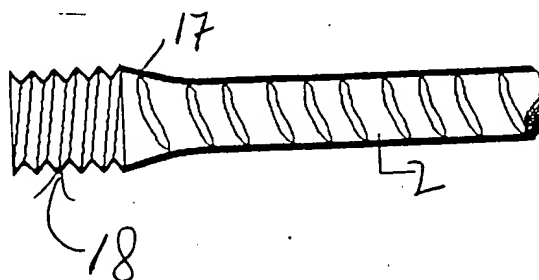


FIG 11

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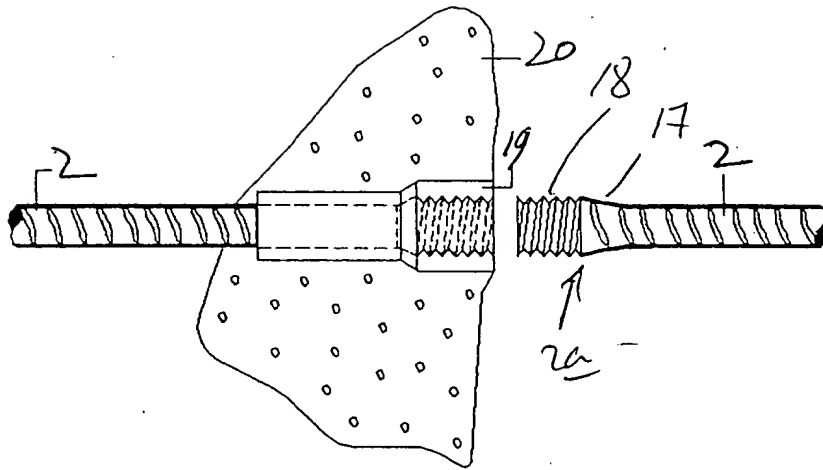


FIG 12

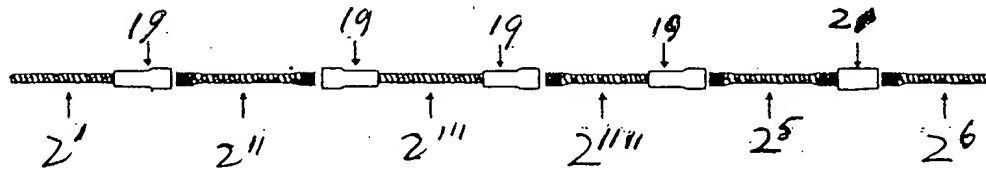


FIG 13

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